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(54) Signalling and control protocol for a communication system.

(57) A signalling and control protocol is provided wherein each subscriber unit (106) operating with a communication system (100) must transmit a request (200, 200' or 200'') to communicate to a central station. If a communication channel is available, the central station returns a channel grant (210), which includes a time code representing a time duration during which the requesting subscriber may communicate. After receiving the channel grant (210), the subscriber unit may communicate for a time interval not exceeding the time duration, and, immediately prior to the expiration of the time duration, the subscriber unit may itself provide a warning tone indicating the impending loss of the communication channel. Conversely, if a communication channel is not available, the central station provides a busy message (216), which includes a code (218) representing the requesting subscriber unit's position in a call request queue.

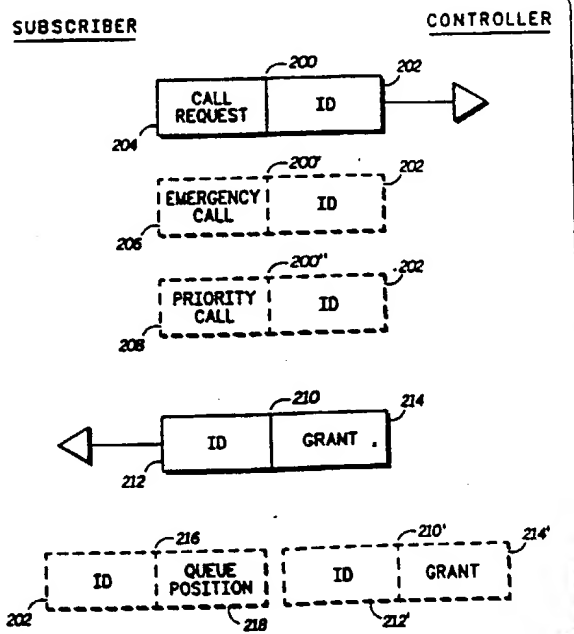


FIG.2

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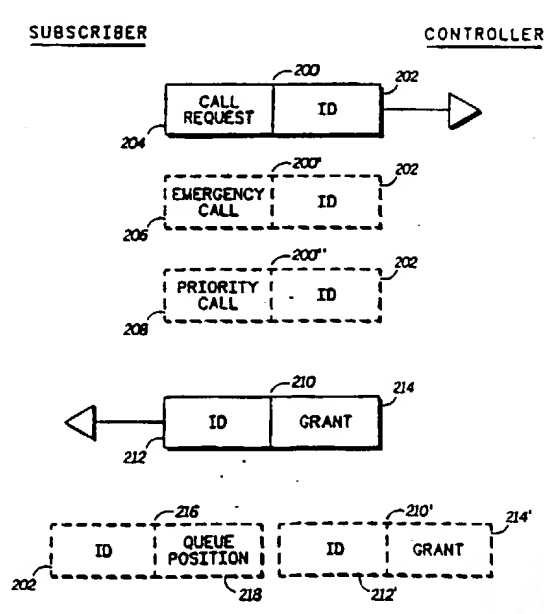
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**FIG.2**

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callers) may access the communication system 100 and communicate with subscribers operating within the communication system 100. Additionally, the controller may send messages to interconnect callers via a voice synthesizer 112, a voice recording, or their functional equivalents.

To establish a call, a requesting subscriber unit 106 is required to transmit a call request to the central station. Preferably, the call request includes information identifying the requesting subscriber and the subscriber(s) with whom the requesting party desires to communicate. If a channel is available, the central station transmits a channel grant, which identifies the communication channel upon which communication may commence. Upon receipt of the channel grant, the requesting subscriber unit 106 moves to the identified communication channel as a transmitting unit, while the called subscriber unit(s) 106' move to the identified communication channel as listening units.

Since the number of communication channels available on the communication system 100 is limited, it is desirable to limit the duration of any single transmission. For full-duplex subscriber units this would not present a significant obstacle since full-duplex subscriber units may transmit and receive information simultaneously. Thus, it is known to transmit a warning tone to full-duplex subscriber units prior to terminating the call and re-allocating the communication channel. However, the present invention contemplates the use of half-duplex (or simplex) subscriber units that operate to transmit or receive (but not both) at any particular instant. Accordingly, if the subscriber unit 106 continued to transmit beyond the time permitted, the central station may be able to transmit a warning tone to the listening subscriber unit(s) 106', but not to the transmitting subscriber unit 106. Therefore, the transmitting subscriber unit 106 would not be warned of the impending call termination. Of course, the communication channel could be reclaimed without warning, however, this would likely confuse and frustrate the subscribers, and impeded efficient communication within the communication system 100.

Referring to Figure 2, an illustration of the signalling and control protocol to establish a call in accordance with the present invention is shown. To establish a call, a requesting subscriber unit 106 must transmit a call request 200 to the central station. Preferably, the call request 200 comprises an identification (ID) portion 202, which includes at least the identification code of the requesting subscriber unit 106, and may include the identification code(s) of the called subscriber(s). Optionally, the ID code(s) of the called subscriber(s) 106' may be located in the call request portion 204, which includes status or control information, such as, the

type of call desired (i.e., calling another subscriber, calling a telephone party, or calling a group of subscribers).

In addition to the "general" call request 200, the present invention contemplates that the requesting subscriber unit 106 may transmit an emergency call request 200', which includes the ID portion 202 and an emergency call portion 206. The emergency call request 200' may be transmitted in those situations requiring immediate action to reduce or prevent the loss of life or damage of property. Preferably, the central station operates to immediately grant a communication channel to any subscriber unit transmitting an emergency call request 200', which includes preempting a communication between other subscriber units (except another emergency call) to allow the subscriber unit requesting the emergency call to have immediate and unlimited access to the communication channel.

In some situations, the subscribers operating within the communication system 100 are organized into a hierarchical arrangement. For example, a police department may be organized with the police chief having the highest priority, followed by district commanders, their lieutenants, various patrol zones, and the individual officers patrolling those zones. Responsive to hierarchical organizations, the present invention contemplates that a requesting subscriber unit 106 may transmit a priority call request 200'', which comprises at least the identification portion 202 and a priority call code 208, which represents one of a plurality of hierarchically organized priority codes corresponding to the hierarchical organization of the subscribers operating within the communication signal 100. According to the invention, the central station operates to grant varying amounts of communication time depending upon the priority level of the requesting subscriber unit.

Upon processing the call request, the central station returns a channel grant code 210, which includes an identification portion 212, which comprises at least the identification code of the requesting subscriber unit 106 and may optionally include the identification code(s) of the called subscriber unit(s) 106'. Optionally, the ID code(s) of the called subscriber unit(s) may be contained in the grant portion 214, which identifies a communication channel upon which to communicate, and also includes a time code representing the time duration that the subscriber units are permitted to communicate. According to the invention, the time code defining the time duration that communication is permitted may be based upon any one or a combination of several factors including: a determination of the current system loading, the time-of-day that the call request was processed; the prior-

proceeds to decision 326, which determines whether a channel is available. If so, the routine proceeds to step 328, where the channel grant code 210 is transmitted to the subscriber units. Preferably, the time code included in the grant portion 214 of the grant code 210 is based upon the priority level of the requesting subscriber in addition to one or more of the system parameters discussed previously. Following this, the call is processed normally (step 329), and at the conclusion of the call, the routine proceeds to reference letter A of Figure 3a. However, if the determination of decision 326 is that a channel is not available, the priority call request 200" is positioned in the call waiting queue in accordance with the priority level of the requesting subscriber. That is, a priority call request 200" may be positioned in the middle, bottom, or at the top of the queue depending upon the priority level of the requesting subscriber unit 106 as compared against the priority of any call request already residing in the waiting queue. In this way, a priority caller may be more rapidly granted a communication channel, as well as being granted an extended time duration to communicate. Following this, the routine proceeds to step 332, where the busy code 216 is transmitted containing the queue position 218 to inform the priority subscriber of his or her position in the waiting queue.

Assuming, however, that the determination of decision 324 is that a priority call request 200" was not received, the routine proceeds to decision 334, which determines whether an interconnect caller has contacted the controller 102 via the PSTN 110 and the telephone interface 108. A negative determination of decision 334 routes control to reference letter A of Figure 3a. However, if an interconnect call has been received, the routine proceeds to decision 336, which determines whether a channel is available. If so, the routine proceeds to step 338, where a channel grant code 210 is transmitted to the called subscriber unit(s) 106', which contains the grant code 214 that identifies the communication channel upon which to communicate and provides a time code representing a time duration for the interconnect call. According to the invention, an interconnect call may be provided with a longer time duration than a "dispatch" (i.e., subscriber-to-subscriber) call. After sending the channel grant code 210, the interconnect call is processed normally (step 340), and at the conclusion of the call, the routine proceeds to reference letter A of Figure 3a. Conversely, if the determination of decision 336 is that a channel is not available, the controller 102 operates to synthesize (112) a busy message, which is transmitted together with the queue position to the interconnect caller via the telephone interface 108 and the PSTN 110. In this way, the interconnect caller may approximate the time dura-

tion before attempting to re-contact the central station.

Referring to Figures 4a and 4b, flow diagrams illustrating the operation of a subscriber unit in accordance with the present invention are shown. The routine begins in step 400, where the requesting subscriber unit 106 transmits a call request (either 200, 200' or 200") to the central station. In step 402, the subscriber unit determines whether the response was received from the central station. If not, decision 404 determines whether a predetermined response time has expired. If not, the routine operates in the "loop" formed by decisions 404 and 402 until a response is received from the central station, or the time for response has expired. If the determination of decision 404 is that the response time has expired, the routine proceeds to decision 406, which determines whether the subscriber unit should retry the call request. According to the invention, each subscriber unit may automatically retry the transmission of the call request if the central station fails to respond. Accordingly, an affirmative determination of decision 406 routes the routine to step 400 where the call request code is re-transmitted. Conversely, a negative determination of decision 406 routes control to step 408, where the subscriber routine exits and the subscriber unit operates normally by performing other tasks in accordance with any operational program stored within the subscriber unit.

Assuming now that the determination of the decision 402 was that a response was received, the routine proceeds to decision 410, which determines whether a busy code 216 was received. If so, the routine proceeds to decision 412, which determines whether the queue position 218 was transmitted with the busy code 216. According to the invention, decision 214 is included in the operational program of the subscriber unit to provide cross-compatibility with communication systems that employ both aspects of the present invention, and those communication systems that limit the transmit time duration but do not implement the queue position aspect of the present invention. According, an affirmative determination of decision 412 routes the routine to step 414, where the subscriber unit displays the received queue position on any suitable display means. Following this, or in the event of a negative determination of decision 412, the routine proceeds to step 416, where a busy indication (such as a audible tone) is activated to inform the subscriber of the busy condition of the communication system 100. Following this, the routine proceeds to reference letter C.

Assuming that the determination of decision 410 was that a busy code was not received, the routine proceeds to decision 418, which determines whether a channel grant code 210 was received. If

(c) displaying said queue position.

8. A method according to claim 7 characterized by the further steps of:  
at a central station:

(a) receiving said message representing said request to communicate; 5

(b) determining how many other requests to communicate will be granted prior to said request of said subscriber unit;

(c) transmitting said code representing said queue position. 10

9. A subscriber unit for a two-way communication system having a central station for allocating at least one communication channel among a plurality of subscriber units, characterized by: 15  
means for transmitting a message representing a request to communicate;  
means for receiving a code representing a time duration during which said subscriber unit may communicate; and, 20  
means for communicating for a time interval not exceeding said time duration.

10. A subscriber unit for a two-way communication system having a central station for allocating at least one communication channel among a plurality of subscriber units, characterized by: 25  
means for transmitting a message representing a request to communicate;  
means for receiving a code representing a queue position indicating a number of other subscriber units that may communicate prior to said subscriber unit being allowed to communicate; and, 30  
means for displaying said queue position.

11. In a two-way communication system having a central station for allocating at least one communication channel among a plurality of subscriber units, and a means for interconnecting a telephone unit to said two-way communication to facilitate communication between telephone units and subscriber units, a method for apprising a telephone unit for an approximate duration until a communication channel becomes available, characterized by the steps of: 35

at the central station:

(a) receiving a signal from a telephone unit representing a request to communicate; 45

(b) determining how many other requests to communicate will be granted prior to said request of said telephone unit;

(c) transmitting a voice message containing an indication of how many other units must communicate prior to said telephone unit being allowed to communicate; 50

at said telephone unit:

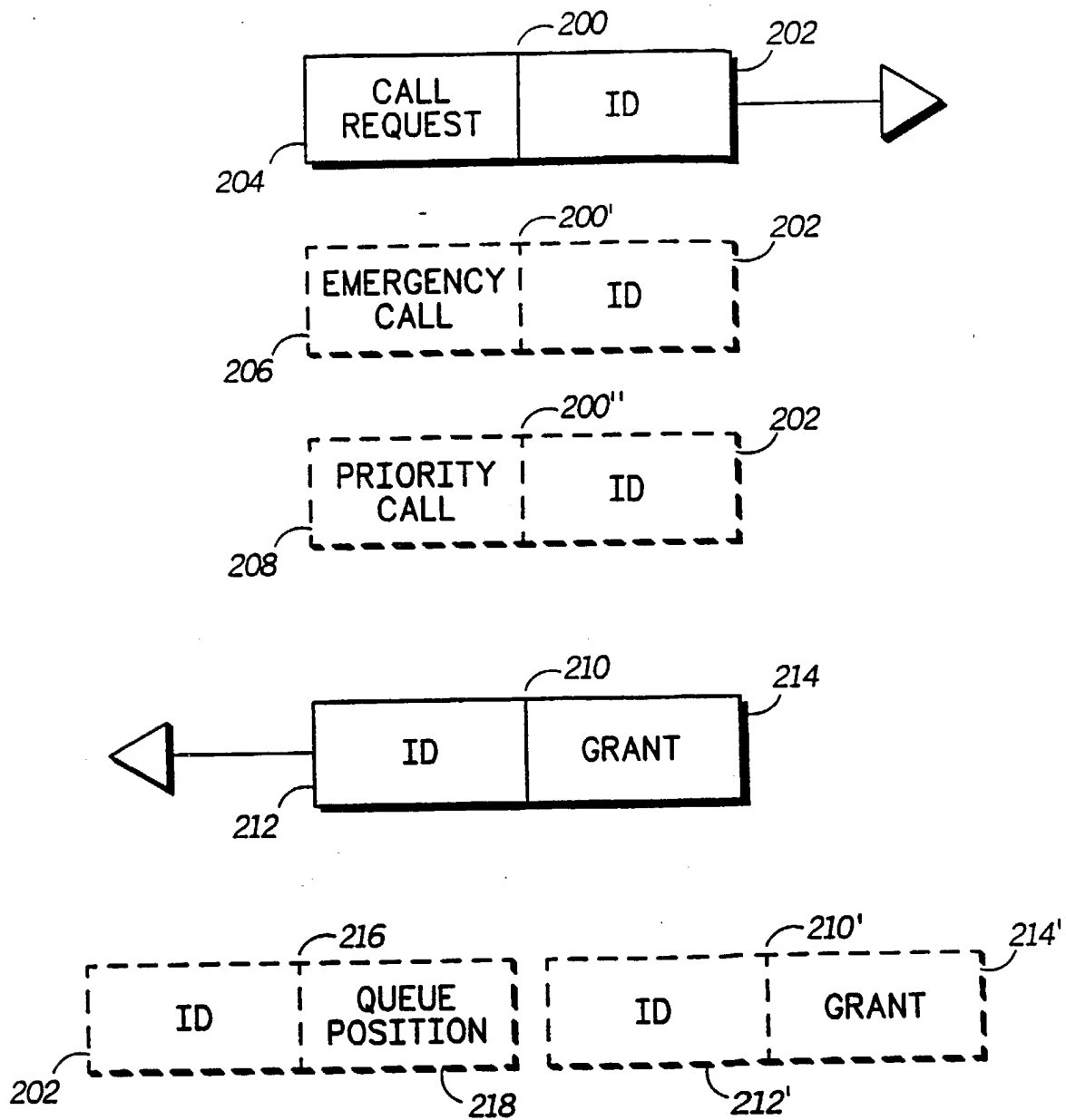
(a) accessing the central station thereby providing said signal; and, 55

(b) receiving said voice message containing said indicating how many other units may communicate

prior to said telephone unit being allowed to communicate.

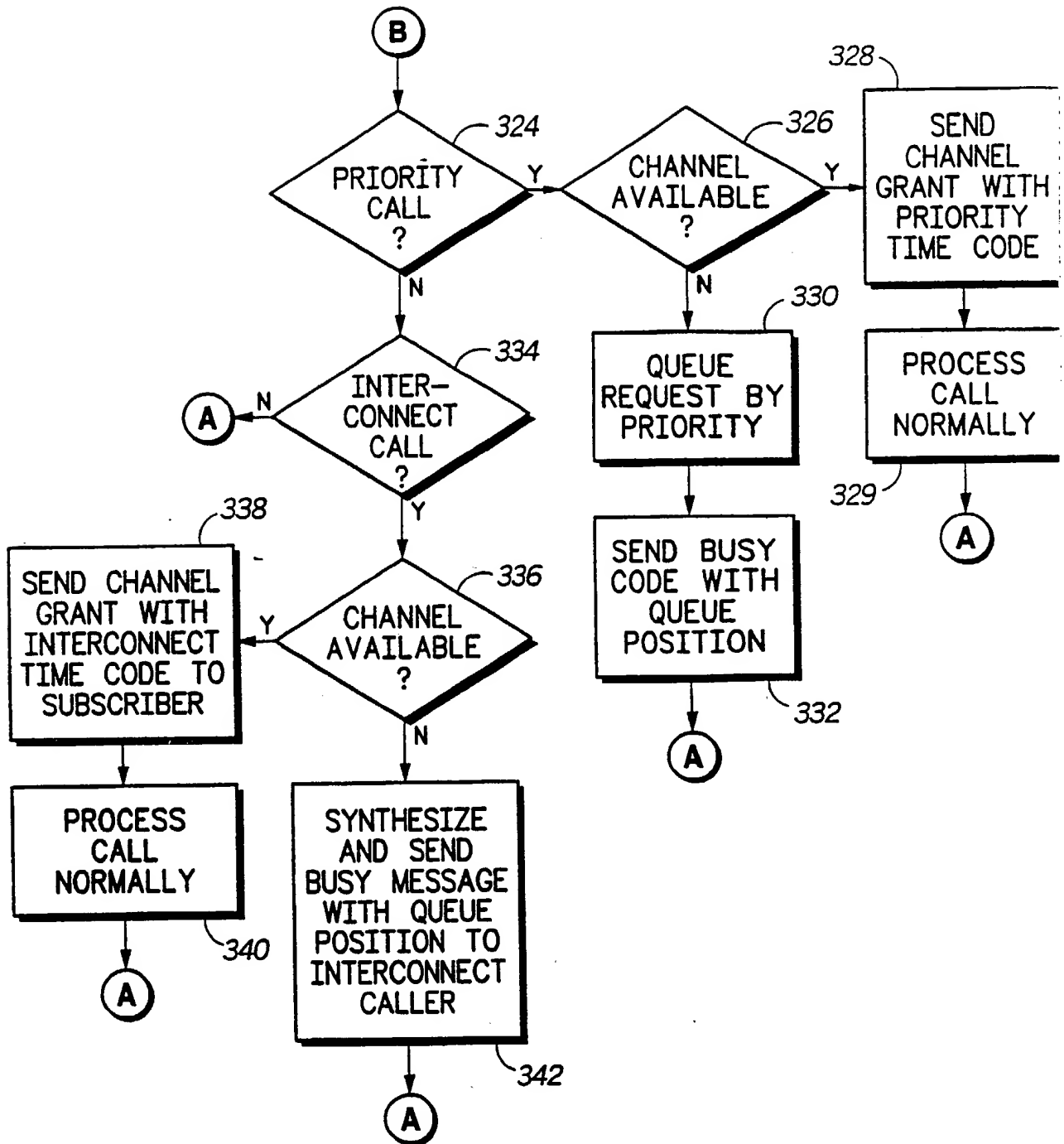
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**FIG.2**

*FIG. 3b*



*FIG. 4b*

